Key Solution

CHEN 490 – Fundamentals of Petroleum Engineering
HW # 3 – Due 31/9/2014

1. A gas reservoir has the following gas composition:

Component	Mole fraction (y_i)
CO_2	0.02
N_2	0.01
C_1	0.85
C_2	0.04
C_3	0.03
i-C_4	0.03
n-C_4	0.02

The initial reservoir pressure and temperature are 3000 psia and 180 F, respectively. Calculate the gas compressibility factor, Z, under reservoir conditions.

2. (a) Compute the initial tank oil in place for the following field:
Area = 1000 acres
Average porosity, ϕ = 18%
Average connate water saturation, S_{wc} = 25%
Formation volume factor, FVF for oil, B_o =1.15
Average sand thickness, h =15 ft

(b) Compute the standard quantity of 0.70 gravity gas which could be contained in the same field.
Reservoir depth = 10000 ft
Static pressure gradient for area = 0.50 psi/ft
Temperature gradient = 1.5/100 ft
Average service temperature 75 F

3. A cylindrical core sample was subjected to the following linear flow test conditions. Compute the sample's permeability in md.
L = 10 cm
μ = 1 cp
Diameter =2 cm
Q = 12 cc/min
P_1 = 44.1 psig
P_2 = 14.7 psia

4. The bulk volume of a core sample was measured in mercury displacement as 25 cc. Pore volume was obtained by saturating the sample with a hydrocarbon solvent as shown by the following data:
W_d = 50.25 gm
W_g = 54.50 gm
ρ = 0.701 gm/cc
(a) What is the sample's porosity?
(b) What is the grain density of this rock?

thh –AUB, 25/9/2014

1. A mixture of gas

Component	y_i	P_{ci}	T_{ci}	yT_{ci}	yP_{ci}
CO_2	0.02	1071.0	547.91	10.96	21.42
N_2	0.01	493.1	227.49	2.27	4.93
C_1	0.85	666.4	343.33	291.83	366.44
C_2	0.04	706.5	549.92	22.00	28.26
C_3	0.03	616.4	666.06	19.98	18.48
$i-C_4$	0.03	527.9	934.46	22.05	15.84
$n-C_4$	0.02	550.6	765.62	15.31	11.01
				$pT_c = 383.38$	$pP_c = 666.38$

1st. Determine the Psendo-Critical pressure

$$PP_c = \sum_{i=1}^{n} y_i P_{ci} = 666.38 \text{ psi}$$

2nd. Determine the Psendo-Critical temperature

$$PT_c = \sum_{i=1}^{n} y_i T_{ci} = 383.38\ ^\circ R$$

3rd. Calculate the psendo-reduced pressure and temperature

$$PP_r = \frac{3000}{666.38} = 4.50$$

$$PT_r = \frac{640}{383.38} = 1.67$$

4th. Determine the Z factor from Chart of Standing and Katz – –

$$Z \cong \underline{0.86}$$

2. Area = 1000 acres
ϕ = 18%, S_{wc} = 25%, B_o = 1.15, h = 15 ft

a) Compute the initial tank oil, (N)

$$N = \frac{7758 A h \phi (1 - S_{wc})}{B_o}$$

$$N = \frac{(7758)(1000)(15)(.18)(.75)}{1.15}$$

$$N = 13.6 \times 10^6 \text{ bbl tank oil}$$

b) Compute the std. quantity of 0.7 gravity gas

Res. depth = 10000 ft

Static Pressure gradient = 0.5 psi/ft $= \frac{dP}{dh}$

Temp. gradient = 1.5/100 ft, $T = 75^\circ F$

Static Pressure, $P_s = (0.5 \text{ psi/ft})(10000 \text{ ft})$

$= 5000$ psi

$$T_{res} = \frac{(1.5)(10000)}{100} = 150^\circ F = 610^\circ R$$

Surface temp. $(T_{sc}) = 75^\circ F + 460 = \underline{\underline{535^\circ R}}$

$V_p = 43560 \phi (1 - S_w)$ ft³/acr-ft

$P_{sc} = 14.7$ psia

$Z_{sc} = 1$

$$G = 43560 \phi (1 - S_w) \times \frac{535}{14.7} \times \frac{P}{ZT}$$

$$G = 43560 (.18)(.75) \times \frac{535}{14.7} \times \frac{5000}{Z(610)_{g.2}} \times (1000)(15)$$

Find Z, $\gamma_g = 0.7$ @ Z = 1

$= 17.4 \times 10^9$ SCF

3. Cylindrical core – For linear flow test

Find k ?

$L = 10$ cm , $\mu = 1$ cp , $d = 2$ cm , $q = 12$ cc/min

$P_1 = 44.1$ psig , $P_2 = 14.7$

$$k = \frac{q \mu L}{A \Delta P}$$

$$= \frac{\left(\frac{12}{60}\right)(1)(10)}{(\pi)(1)^2 \frac{44.1}{14.7}}$$

$= 0.210$ darcy or ≈ 210 md

4. A core sample $V_b = 25$ cc

$V_p = ?$

$W_d = 50.25$ gm = weight dry

$W_g = 54.50$ gm = Saturated with gas

$\rho = 0.701$ gm/cc

a) what is the sample ϕ ?

$$V_p = \frac{W_g - W_d}{\rho} = \frac{54.5 - 50.25}{0.701}$$

$$= 6.06 \text{ cc}$$

$$\phi = \frac{6.06}{25} = 0.242 \text{ or } 24.2\%$$

b) What is the grain density of this rock ?

$$\rho_{grain} = \frac{W_d}{V_g} = \frac{W_d}{V_b(1-\phi)}$$

$$= \frac{50.25}{25(1-.242)}$$

$$= 2.65 \text{ gm/cc}$$